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Other:

DATA VALIDATION AND STATISTICAL EVALUATION OF DECEMBER 2010 GROUNDWATER QUALITY DATA

CITY OF HELENA LANDFILL

Prepared For:

CITY OF HELENA
HELENA, MONTANA



Hydrometrics, Inc.
consulting scientists and engineers

FEBRUARY 2011

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MAR 09 2011

DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

**DATA VALIDATION AND STATISTICAL
EVALUATION OF DECEMBER 2010
GROUNDWATER QUALITY DATA**

CITY OF HELENA LANDFILL

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HELENA, MONTANA**



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Hydrometrics, Inc.
consulting scientists and engineers

3020 Bozeman Avenue
Helena, MT 59601
(406) 443-4150
Fax: (406) 443-4155
www.hydrometrics.com

March 8, 2011

Mr. Martin Van Oort
Environmental Science Specialist
Solid Waste Regulatory Program
Montana Department of Environmental Quality
P.O. Box 200901
Helena, MT 59620-0901

RJ
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MAR 09 2011

DEPT. OF ENVIRO. QUALITY
WASTE & UNDERGROUND TANK
MANAGEMENT BUREAU

RE: Statistical Evaluation of December 2010 Groundwater Quality Data

Dear Martin,

On behalf of the City of Helena, Hydrometrics validated and statistically evaluated groundwater quality data for samples collected at the City's municipal landfill in December 2010. After receiving approval from John Rundquist of the City of Helena, I am forwarding a copy of the report "Data Validation and Statistical Evaluation of December 2010 Groundwater Quality Data City of Helena Landfill" for your review.

If you have any questions concerning this report, please don't hesitate to call.

Sincerely,

Jodi Bingham, P.E.
Environmental Engineer/Chemist

Enclosure

c: John Rundquist, City of Helena, without Enclosure
Ben Sautter, City of Helena, without Enclosure
Mike Wignot, Hydrometrics, without Enclosure

TABLE OF CONTENTS

DATA VALIDATION AND STATISTICAL EVALUATION OF DECEMBER 2010 GROUNDWATER QUALITY DATA

CITY OF HELENA LANDFILL

Prepared for:

Mr. John Rundquist
CITY OF HELENA
City/County Building
316 North Park Avenue
Helena, MT 59623

Prepared by:

Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

February 2011

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES	ii
LIST OF FIGURES.....	iii
LIST OF APPENDICES	iii
1. REPORT OBJECTIVES	1-1
2. SITE DESCRIPTION	2-1
2.1 PHYSICAL FEATURES	2-1
2.2 WELL LOCATIONS.....	2-1
2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY.....	2-4
2.4 CURRENT ACTIVITIES.....	2-5
3. SUMMARY OF DECEMBER 2010 DATA VALIDATION REPORT.....	3-1
4. STATISTICAL DATA EVALUATION AND COMPARISON.....	4-1
4.1 DOWNGRAIDENT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIENT WATER QUALITY	4-1
4.2 INTER-WELL PREDICTION INTERVAL ANALYSIS	4-7
4.3 TREND ANALYSIS	4-7
4.4 TEMPORAL CONCENTRATION PLOTS.....	4-9
5. DOMESTIC WELL DATA EVALUATION	5-1
6. SUMMARY AND CONCLUSIONS	6-1
7. REFERENCES	7-1

LIST OF TABLES

TABLE 2-1. GROUNDWATER VELOCITIES	2-4
TABLE 4-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS FOR THE DECEMBER 2010 MONITORING EVENT	4-2

TABLE 4-2.	COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS AND MCLs FOR THE DECEMBER 2010 SAMPLING EVENT	4-3
TABLE 4-3.	COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS AND MCLs FOR ALL SAMPLING EVENTS TO DATE	4-4
TABLE 4-4.	RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS	4-8
TABLE 4-5.	RESULTS OF MANN-KENDALL TREND ANALYSES	4-9

LIST OF FIGURES

FIGURE 2-1.	VICINITY MAP	2-2
FIGURE 2-2.	STUDY AREA AND DECEMBER 2010 POTENTIOMETRIC SURFACE	2-3
FIGURE 4-1.	TEMPORAL TRENDS IN TETRACHLOROETHENE CONCENTRATIONS AT SELECTED DOWNGRADIENT WELLS	4-11
FIGURE 4-2.	TEMPORAL TRENDS IN NITRATE CONCENTRATIONS AT SELECTED WELLS	4-12
FIGURE 5-1.	TEMPORAL TRENDS IN PCE CONCENTRATIONS IN DOMESTIC WELLS	5-2

LIST OF APPENDICES

APPENDIX A	DATA VALIDATION REPORT (APPENDICES IN DIGITAL FORMAT)
APPENDIX B	STATISTICAL ANALYSIS REPORTS (IN DIGITAL FORMAT)

**DATA VALIDATION AND STATISTICAL
EVALUATION OF DECEMBER 2010
GROUNDWATER QUALITY DATA
CITY OF HELENA LANDFILL**

1. REPORT OBJECTIVES

This report is prepared on behalf of the City of Helena Landfill to fulfill the groundwater data evaluation requirements provided in Administrative Rules, Montana (ARM) Title 17, Chapter 50. This report provides analytical results for groundwater samples collected at monitoring wells during the December 2010 monitoring event, summarizes the data validation results and statistically evaluates the data. The samples were collected and analyzed in accordance with the Montana Department of Environmental Quality (MDEQ) approved sampling and analysis plan (Hydrometrics, 2008).

ARM 17.50.1305(8) and ARM 17.50.1305(9) stipulate the types of statistical data evaluations to be performed on groundwater quality monitoring data from regulated landfills. Federal guidance on conducting statistical evaluations of groundwater data is also available (EPA, 1989; EPA, 1992). These regulations and guidance documents allow the use of a wide range of statistical procedures including: parametric analysis of variance, non-parametric analysis of variance, tolerance or prediction interval testing, trend tests, or other statistical tests meeting the statistical testing objectives of the rules.

Statistical evaluations have been performed for this site semiannually since 1993 and the following conclusions have been reached based on the results of those evaluations:

- Chlorinated hydrocarbons occur downgradient of the landfill;
- Tetrachloroethene (PCE) is the chlorinated organic compound of greatest concern due to Maximum Contaminant Level (MCL) exceedances;

- Concentrations of PCE are decreasing over time in well EPA-1, the well that has historically shown the highest concentrations, and in compliance wells HL-90-1, HL-99-1, HL-99-2, and HL-99-3; and
- Elevated nitrate plus nitrite as N (nitrate) concentrations exist both upgradient and downgradient of the landfill at similar levels.

These findings are further evaluated in this December 2010 statistical report through an assessment of current concentrations (Table 3-1), a comparison of summary statistics (Tables 3-2 and 3-3), an inter-well prediction analysis (Table 3-4), and an examination of temporal trends (Table 3-5 and Figures 3-1 and 3-2).

2. SITE DESCRIPTION

2.1 PHYSICAL FEATURES

A site location map is provided in Figure 2-1. The landfill is surrounded for several miles in all directions by residential, commercial and industrial zoned property. There are several businesses upgradient of the landfill, which have the potential to affect groundwater quality in the area.

A site plan is shown on Figure 2-2. The landfill is divided into three sections. The southern part of the landfill (Phase I and Phase II sections) is unlined and was in operation until the early 1980s. The northern part of the landfill (Phase III) is also unlined, and was in operation until November 1993. The Phase III landfill has been capped with an 18-inch clay cover to minimize surface water percolation through the landfill and subsequent migration of chemicals into groundwater.

2.2 WELL LOCATIONS

Fourteen monitoring wells located around the landfill are typically included in the groundwater monitoring program and are characterized as follows:

- Background wells: HL-06-1 (replacing 83-6), HL-94-1R, HL-94-2R, MPC-5;
- Downgradient wells: HL-90-1, HL-90-2, HL-90-3, MPC-1, MPC-2, EPA-1, HL-99-1, HL-99-2, HL-99-3; and
- Cross-gradient well: HL-94-3.

As discussed in Section 2.4 and in accordance with the approved sampling and analysis plan (Hydrometrics, 2008), only eight of these wells were included on the sampling schedule for the December 2010 sampling event. The locations of these wells are shown in Figure 2-2.



NO SCALE

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF DECEMBER 2010
GROUNDWATER QUALITY DATA

VICINITY MAP

FIGURE

2-1



SITE CODE	DTWL	MPE	SWL
Dec-10			
HL-06-1	17.03	3993.62	3976.59
82-3	66.46	3973.51	3907.05
EPA-1	47.04	3981.08	3934.04
HL-10-1	56.06	3943.01	3886.95
HL-90-1	55.41	3942.48	3887.07
HL-90-2	47.90	3950.96	3903.06
HL-90-3	60.09	3958.29	3898.20
HL-94-1R	57.85	3994.04	3936.19
HL-94-2R	34.42	3967.64	3933.22
HL-94-3	35.82	3967.38	3931.56
HL-99-1	55.71	3943.15	3887.44
HL-99-2	56.81	3945.75	3888.94
HL-99-3	52.48	3948.05	3895.57
INF. GALLE	6.49	3918.89	3912.40
I-1	64.16	3899.59	3835.43
MPC-1	23.40	3946.08	3922.68
MPC-2	17.72	3936.09	3918.37
MPC-5	55.19	3990.14	3934.95



SCALE

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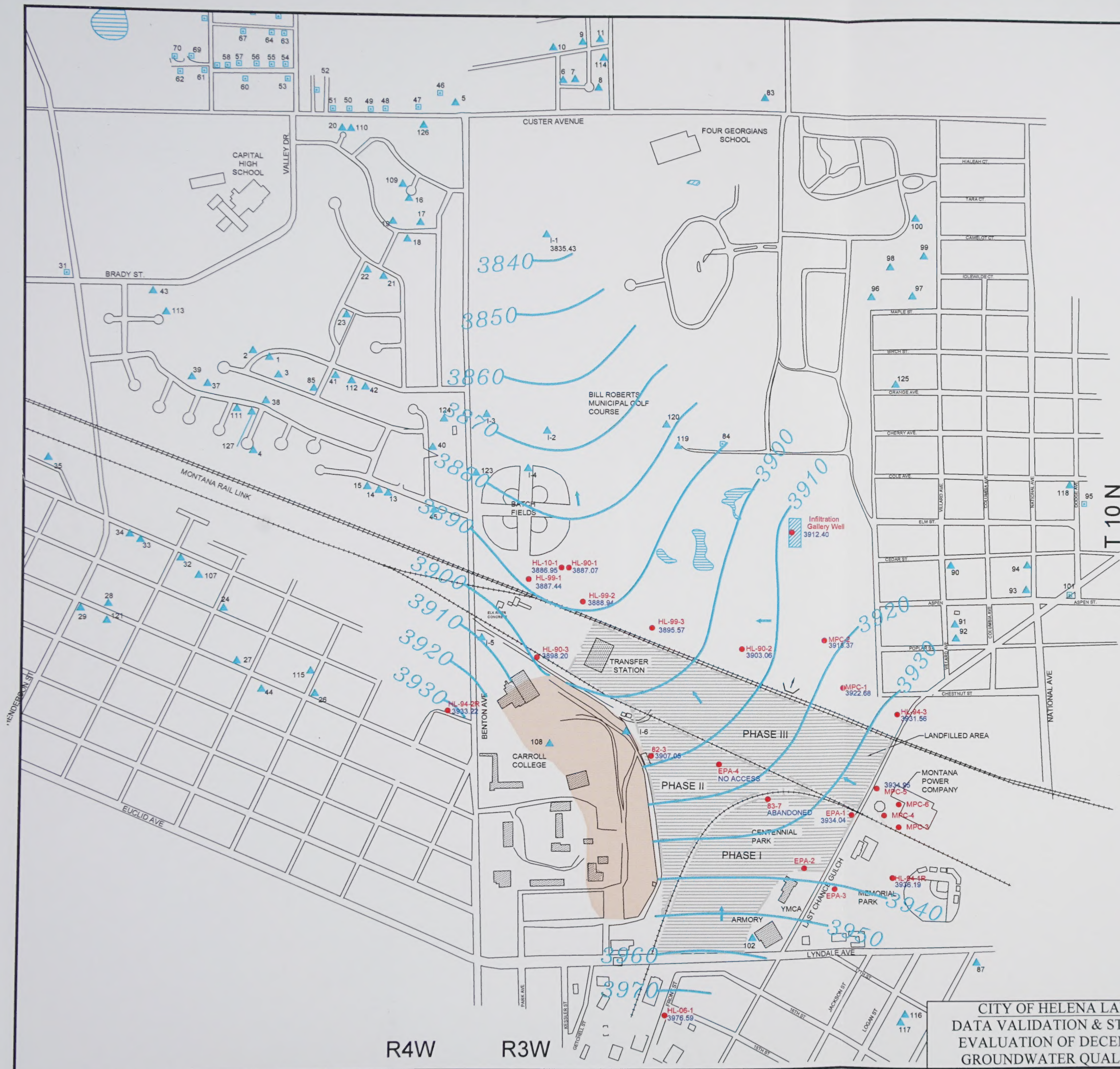
LEGEND

- HL-1 ■ PIEZOMETER
- 83-8 ● MONITORING WELL
- I-6 ▲ IRRIGATION WELL
- 80 □ DOMESTIC WELL
- INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
- AREA OF SHALLOW LOW PERMEABILITY BEDROCK
- POTENTIOMETRIC CONTOUR LINE
- INFERRED GROUNDWATER FLOW DIRECTION
- STORM WATER OUTFALL FOR LAST CHANCE GULCH

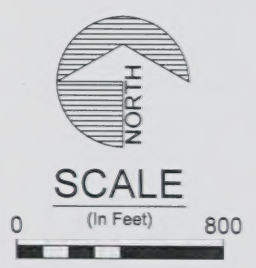
STUDY AREA AND DECEMBER 2010
POTENTIOMETRIC SURFACE

FIGURE

2-2



SITE CODE	DTWL	MPE	SWL
Dec-10			
HL-06-1	17.03	3993.62	3976.59
82-3	66.46	3973.51	3907.05
EPA-1	47.04	3981.08	3934.04
HL-10-1	56.06	3943.01	3886.95
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HL-90-3	60.09	3958.29	3898.20
HL-94-1R	57.85	3994.04	3936.19
HL-94-2R	34.42	3967.64	3933.22
HL-94-3	35.82	3967.38	3931.56
HL-99-1	55.71	3943.15	3887.44
HL-99-2	56.81	3945.75	3888.94
HL-99-3	52.48	3948.05	3895.57
INF. GALLE	6.49	3918.89	3912.40
I-1	64.16	3899.59	3835.43
MPC-1	23.40	3946.08	3922.68
MPC-2	17.72	3936.09	3918.37
MPC-5	55.19	3990.14	3934.95



- LEGEND**
- HL-1 ■ PIEZOMETER
 - 83-6 ● MONITORING WELL
 - I-6 ▲ IRRIGATION WELL
 - 80 □ DOMESTIC WELL
 - INFILTRATION GALLERY (GROUNDWATER COLLECTION SYSTEM)
 - AREA OF SHALLOW LOW PERMEABILITY BEDROCK
 - 3900 — POTENTIOMETRIC CONTOUR LINE
 - INFERRED GROUNDWATER FLOW DIRECTION
 - ↓ STORM WATER OUTFALL FOR LAST CHANCE GULCH

CITY OF HELENA LANDFILL
DATA VALIDATION & STATISTICAL
EVALUATION OF DECEMBER 2010
GROUNDWATER QUALITY DATA

STUDY AREA AND DECEMBER 2010
POTENTIOMETRIC SURFACE

FIGURE
2-2

2.3 GROUNDWATER FLOW DIRECTION AND VELOCITY

Figure 2-2 shows water level elevations observed in December 2010 and groundwater potentiometric surface contours. Groundwater flow direction is also shown on this figure. The general groundwater flow direction in the vicinity of the landfill is to the north-northwest. The potentiometric surface in the area of well HL-94-3 suggests that groundwater flows to the west northwest (Figure 2-2); thus, well HL-94-3 is not considered to be upgradient or downgradient of the landfill. Well HL-94-3 has, therefore, been designated as a “cross-gradient” well.

Table 2-1 shows the groundwater velocities calculated for each of the monitoring wells sampled during the December 2010 sampling event. Slope was determined from the potentiometric contours shown in Figure 2-2. The hydraulic conductivities were obtained from the groundwater flow model inputs included in the report “Evaluation of Groundwater Extraction Remediation Alternative at the Helena Landfill” (Hydrometrics, 1999a). The porosity for each well was assumed to be 0.25. An average regional gradient of 0.0235 ft/ft was determined between monitoring well HL-06-1 and I-1. This yields an average regional velocity of 0.765 ft/day.

TABLE 2-1. GROUNDWATER VELOCITIES

Well	Hydraulic Conductivity (ft/day)	Slope (ft/ft)	Velocity (ft/day)
HL-06-1	0.03	0.0355	0.00426
HL-10-1	20	0.0203	1.63
HL-90-1	20	0.0203	1.63
HL-94-1R	2.8	0.0120	0.134
HL-99-1	10	0.0304	1.22
HL-99-2	20	0.0186	1.49
HL-99-3	20	0.0107	0.858
MPC-5	2.8	0.0199	0.223

2.4 CURRENT ACTIVITIES

New modifications to Centennial Park, located over the old landfill, began in June of 2010 and continued through November. Construction work included the installation of fill material and associated utilities, the expansion and resurfacing of the YMCA parking lot, construction of new roads and trails as well as a stormwater collection pond, and the installation of a new automatic watering system and other new park related facilities. All modifications to the park were reviewed to ensure the integrity of the landfill cap would be maintained and that the final design would be even more protective of human health and the environment than the current design. All plans were submitted to MDEQ prior to construction. Construction activities were conducted in a manner to preserve the existing monitoring wells and the corrective measures previously implemented.

3. SUMMARY OF DECEMBER 2010 DATA VALIDATION REPORT

Eight monitoring wells around the landfill and two domestic wells were included in the December 2010 sampling event. The monitoring sites for this event for the City of Helena Landfill include the following:

- Monitoring wells HL-06-1, HL-10-1, HL-90-1, HL-94-1R, HL-99-1, HL-99-2, HL-99-3, MPC-5; and
- Domestic wells 5 and 16.

Analytical parameters included metals, volatile organics, semi-volatile organics, halogenated organics, and major anions for the monitoring wells and volatile organics, semi-volatile organics, and halogenated organics for the domestic wells as specified in the approved sampling and analysis plan (Hydrometrics, 2008). In addition, to obtain a complete potentiometric map, static water levels (SWL) were obtained from eight additional monitoring wells, an irrigation well, and the infiltration gallery. The SWL sites for the latest sampling event include the following:

- Monitoring wells 82-3, HL-06-1, EPA-1, EPA-4, HL-10-1, HL-90-1, HL-90-2, HL-90-3, HL-94-1R, HL-94-2R, HL-94-3, HL-99-1, HL-99-2, HL-99-3, MPC-1, MPC-2, MPC-5;
- Irrigation well I-1; and
- The infiltration gallery.

The water samples collected for the City of Helena Landfill in December 2010 have been validated by the Hydrometrics' Data Validation Department in accordance with the project work plan, "Revised Sampling and Analysis Plan, City of Helena Landfill, Groundwater, Surface Water and Landfill Gas Monitoring Activities" (Hydrometrics, 2008). Lab and field quality control procedures were appropriate; quality control (QC) samples included a field duplicate (collected at HL-10-1), a trip blank, a rinseate blank, a D.I. blank, and standard

internal laboratory QC samples. No parameters were reported as above the reporting limit in the trip blank, rinseate blank, or D.I. blank. The duplicate sample pair showed very good agreement, compared with the control limits presented in EPA guidance. The entire data validation report is included as Appendix A of this report. Overall, the City of Helena Landfill data for December 2010 were deemed acceptable for the purposes of the project as outlined in the work plan.

1. Comparison of applicable state quality control and assurance data collected during the sampling event with laboratory results for the same parameters.
2. Comparison of applicable state quality control and assurance data collected during the sampling event with laboratory results for the same parameters.
3. Trend analysis.
4. Response to non-compliance.

The following information includes all data parameters for which results were reported above the detection limit in any of the monitoring wells during December 2010 sampling event.

The data for metals, nutrients, pesticides, and other parameters for DDT and others, the only parameters that exceeded their respective limits in department wells. Data from all wells were used. Data for DDT were used above the detection limit of 100 ng/L and other metals above 10 ng/L or 10 ng/L or with potentially increasing levels in the future.

4.1. DEGRADATION WATER QUALITY COMPARISONS WITH CRITERIA AND DEGRADATION WATER QUALITY

The following monitoring wells were used for the December 2010 data and laboratory results are shown in Tables 4.1, 4.2, and 4.3.

Table 4.1 is the December 2010 sampling results for Tables 4.1 and 4.2, the 2.5-meter parameter data were used only in the 2.5-meter data and were not used in the 1.5-meter data. The 1.5-meter data were used in the 1.5-meter data and were not used in the 2.5-meter data.

4. STATISTICAL DATA EVALUATION AND COMPARISON

Four types of data evaluations were conducted using the December 2010 sample results for the six monitoring wells sampled in the vicinity of the landfill. The two domestic wells are evaluated separately in Section 5. The four types of data evaluations conducted are:

1. Comparisons of applicable water quality criteria and upgradient (also called “background”) water quality with summary statistics of downgradient concentrations for December 2010 and all samples to date;
2. Inter-well prediction interval analysis;
3. Trend analysis; and
4. Temporal concentration plots.

The first three analyses include all those parameters for which results were reported above the detection limit in any of the monitoring wells for the December 2010 sampling event.

The fourth evaluation, temporal concentration plots, was performed for PCE and nitrate, the only constituents that currently exceed their regulatory limits in downgradient wells. Data from all wells which have historically shown PCE results above the detection limit of 0.001 mg/L and nitrate results above the MCL of 10 mg/L or with potentially increasing trends were evaluated.

4.1 DOWNGRADIENT WATER QUALITY COMPARISONS WITH CRITERIA AND UPGRADIENT WATER QUALITY

The following conclusions are derived from the December 2010 data and summary statistics in Tables 4-1, 4-2, and 4-3:

- (a) For the December 2010 sampling event (Tables 4-1 and 4-2), the following parameters were detected only in background (also called upgradient) wells: nickel, selenium, 1,1,1-trichloroethane, and bromodichloromethane. Parameters detected in only

**TABLE 4-1. SUMMARY OF PARAMETER CONCENTRATIONS IN LANDFILL MONITORING WELLS
FOR THE DECEMBER 2010 MONITORING EVENT**

Parameter	Downgradient Wells					Upgradient Wells			MCL ⁽¹⁾
	HL-10-1	HL-90-1	HL-99-1	HL-99-2	HL-99-3	HL-06-1	MPC-5	HL-94-1R	
pH (s.u.)	7.8	7.9	7.9	7.9	8.0	7.8	7.7	8.0	NA
Specific Conductance (µmhos/cm)	1230	1400	1250	954	947	1080	2670	981	NA
Sulfate	130	130	150	130	150	100	470	84	NA
Chloride	110	170	95	49	53	28	20	25	NA
Nitrate+Nitrite as N	9.05	9.08	8.90	7.57	8.82	3.33	12.8	4.88	10
Arsenic (Dissolved)	<0.005	<0.005	<0.005	<0.005	0.009	<0.005	0.005	<0.005	0.010
Iron (Dissolved)	<0.03	<0.03	0.39	0.14	0.38	<0.03	1.68	<0.03	0.3 ⁽²⁾
Nickel (Dissolved)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	0.1
Selenium (Dissolved)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	0.005	0.05
Zinc (Dissolved)	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2
1,1,1-Trichloroethane	<0.001	<0.001	<0.001	<0.001	<0.001	0.0034	<0.001	<0.001	0.2
1,1-Dichloroethane	0.0018	0.0018	<0.001	0.0027	0.0018	<0.001	<0.001	<0.001	NA
Bromodichloromethane	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0022	0.010
Chloroform	<0.001	<0.001	0.0027	0.0020	0.0024	<0.001	<0.001	0.017	0.07
Cis-1,2-Dichloroethene	0.0015	0.0014	0.0017	<0.001	<0.001	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	0.0014	<0.001	<0.001	0.0023	<0.001	<0.001	<0.001	<0.001	1
Tetrachloroethene (PCE)	0.0065	0.0060	0.0032	0.0059	0.0051	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	0.0014	0.0013	<0.001	0.0012	<0.001	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	<0.005	<0.005	<0.005	<0.005	0.029	<0.005	10.4	<0.005	0.2
Chemical Oxygen Demand (COD)	<1	2	3	1	4	1	30	5	NA

Concentrations are in mg/L, except as indicated.

NM = not measured

(1) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(2) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL.

**TABLE 4-2. COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR THE DECEMBER 2010 SAMPLING EVENT**

Parameter	June 2010 Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	5/5	7.8	7.90	7.9	8.0	HL-99-3	3/3	7.83	7.8	8.0	NA
Specific Conductance (µmhos/cm)	5/5	947	1156.2	1230	1400	HL-90-1	3/3	1577.0	1080	2670	NA
Sulfate	5/5	130	138.0	130	150	HL-99-1	3/3	218.0	100	470	NA
Chloride	5/5	49	95.4	95	170	HL-90-1	3/3	24.3	25	28	NA
Nitrate+Nitrite as N	5/5	7.57	8.68	8.9	9.1	HL-90-1	3/3	7.00	4.9	12.8	10
Arsenic (Dissolved)	1/5	<0.005	<u>0.006</u>	<0.005	<u>0.009</u>	HL-99-3	1/3	0.0050	<0.005	0.005	0.010
Iron (Dissolved)	3/5	<0.03	0.19	0.14	0.39	HL-99-1	1/3	0.580	<0.03	1.68	0.3 ⁽⁶⁾
Nickel (Dissolved)	0/5	<0.01	<0.01	<0.01	<0.01	NA	1/3	0.013	<0.01	0.02	0.10
Selenium (Dissolved)	0/5	<0.005	<0.005	<0.005	<0.005	NA	2/3	0.0053	0.005	0.006	0.05
Zinc (Dissolved)	1/5	<0.01	<u>0.01</u>	<0.01	<u>0.01</u>	HL-99-1	0/3	<0.01	<0.01	<0.01	2
1,1,1-Trichloroethane	0/5	<0.001	<0.001	<0.001	<0.001	NA	1/3	0.0018	<0.001	0.0034	0.2
1,1-Dichloroethane	4/5	<0.001	<u>0.0018</u>	<u>0.0018</u>	<u>0.0027</u>	HL-99-2	0/3	<0.001	<0.001	<0.001	NA
Bromodichloromethane	0/5	<0.001	<0.001	<0.001	<0.001	NA	1/3	0.0014	<0.001	0.0022	0.010
Chloroform	3/5	<0.001	0.0018	0.0020	0.0027	HL-99-1	1/3	0.0063	<0.001	0.017	0.07
Cis-1,2-Dichloroethene	3/5	<0.001	<u>0.0013</u>	<u>0.0014</u>	<u>0.0017</u>	HL-99-1	0/3	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	2/5	<0.001	<u>0.0013</u>	<0.001	0.0023	HL-99-2	0/3	<0.001	<0.001	<0.001	1
Tetrachloroethene (PCE)	5/5	<u>0.0032</u>	0.0053	0.0059	0.0065	HL-10-1	0/3	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	3/5	<0.001	<u>0.0012</u>	<u>0.0012</u>	<u>0.0014</u>	HL-10-1	0/3	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	1/5	<0.005	0.010	<0.005	0.029	HL-99-3	1/3	3.47	<0.005	10.4	0.2
Chemical Oxygen Demand (COD)	4/5	<1	2.2	2	4	HL-99-3	3/3	12.0	5	30	NA

(1) Downgradient wells are: HL-10-1, HL-90-1, HL-99-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: HL-06-1, MPC-5, HL-94-1R.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

**TABLE 4-3. COMPARISON OF DOWNGRADIENT CONCENTRATIONS WITH BACKGROUND CONCENTRATIONS
AND MCLs FOR ALL SAMPLING EVENTS TO DATE**

Parameter	Period of Record Downgradient Well Concentrations (mg/L) ⁽¹⁾						Comparison Values (mg/L)				
	D.F. ⁽³⁾	Min.	Mean ⁽⁴⁾	Median	Max.	Max. Location	Background / Upgradient Wells ⁽²⁾				MCL ⁽⁵⁾
							D.F. ⁽³⁾	Mean ⁽⁴⁾	Median	Max.	
pH (s.u.)	103/103	7.1	7.51	7.5	8.0	HL-99-3	93/93	7.42	7.5	8.0	NA
Specific Conductance (µmhos/cm)	101/101	178	952.4	947	1400	HL-90-1	90/90	1483.0	903	4170	NA
Sulfate	103/103	15	134.3	131	190	HL-99-1	93/93	338.8	123	1980	NA
Chloride	103/103	29	45.5	41	170	HL-90-1	92/93	31.1	25	195	NA
Nitrate+Nitrite as N	97/97	4.75	8.04	8.15	11.1	HL-99-1	88/88	12.82	7.28	73	10
Arsenic (Dissolved)	2/102	<0.005	0.0051	<0.005	0.01	HL-99-3	19/95	0.0055	<0.005	0.037	0.010
Iron (Dissolved)	32/102	<0.03	0.094	<0.03	1.0	HL-99-1	43/93	0.401	<0.03	3.14	0.3 ⁽⁶⁾
Nickel (Dissolved)	0/96	<0.01	<0.01	<0.01	<0.01	NA	20/90	0.011	<0.01	0.05	0.1
Selenium (Dissolved)	1/102	<0.005	0.0050	<0.005	0.006	HL-99-2	26/95	0.0054	<0.005	0.01	0.05
Zinc (Dissolved)	11/97	<0.01	0.012	<0.01	<u>0.09</u>	HL-90-1	10/90	0.010	<0.01	0.03	2
1,1,1-Trichloroethane	46/175	<0.001	0.0015	<0.001	<u>0.0074</u>	HL-90-1	13/99	0.0013	<0.001	0.0057	0.2
1,1-Dichloroethane	140/175	<0.001	<u>0.0021</u>	<u>0.002</u>	<u>0.0052</u>	HL-99-3	0/99	<0.001	<0.001	<0.001	NA
Bromodichloromethane	0/175	<0.001	<0.001	<0.001	<0.001	NA	10/99	0.0012	<0.001	0.0048	0.010
Chloroform	165/175	<0.001	0.0024	0.0023	0.0055	HL-90-1	72/99	0.0055	0.0029	0.037	0.07
Cis-1,2-Dichloroethene	52/168	<0.001	<u>0.0012</u>	<0.001	<u>0.0025</u>	HL-99-1	0/94	<0.001	<0.001	<0.001	0.07
Dichlorodifluoromethane	121/175	<0.001	<u>0.0020</u>	<0.001	<u>0.015</u>	HL-90-1	0/99	<0.001	<0.001	<0.001	1
Tetrachloroethene (PCE)	173/175	<0.001	0.0072	<u>0.006</u>	0.024	HL-99-3	0/99	<0.001	<0.001	<0.001	0.005
Trichloroethene (TCE)	102/175	<0.001	<u>0.0013</u>	<u>0.0011</u>	<u>0.0032</u>	HL-99-3	0/99	<0.001	<0.001	<0.001	0.005
Cyanide (Total)	37/102	<0.005	0.0102	<0.005	0.058	HL-99-2	27/94	1.41	<0.005	10.9	0.2
Chemical Oxygen Demand (COD)	59/101	<1	2.92	2	25	HL-99-3	69/93	14.1	7	75	NA

(1) Downgradient wells are: HL-10-1, HL-90-1, HL-99-1, HL-99-2, HL-99-3.

(2) Background / Upgradient wells are: 83-6, HL-06-1, MPC-5, HL-94-1R.

(3) Detection frequency (D.F.), i.e. the number of detections over the total number of samples analyzed for that parameter.

(4) Means calculated using the detection limit for non-detected sample results.

(5) Primary Maximum Contaminant Levels promulgated under the Safe Drinking Water Act for protection of public drinking water supplies.

NA indicates no MCL has been promulgated.

(6) Secondary Maximum Contaminant Level based on aesthetic properties such as taste, odor, and staining.

Values in **bold** exceed the MCL. Underlined values exceed the maximum background/upgradient concentration.

downgradient wells include: zinc, 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, tetrachloroethene (PCE), and trichloroethene (TCE).

- (b) Parameters historically detected only in background wells (Table 4-3) include: nickel and bromodichloromethane. Parameters historically detected in only downgradient wells include: 1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE.
- (c) Nitrate, iron, cyanide, and PCE were reported at concentrations exceeding MCL criteria in the December 2010 sampling event (Tables 4-1 and 4-2). The MCLs for nitrate and cyanide were both exceeded in a single upgradient well (MPC-5); the MCL for PCE was exceeded in four downgradient wells (HL-10-1, HL-90-1, HL-99-2 and HL-99-3); the secondary MCL (based on aesthetic properties rather than human health standards) for iron was exceeded in a single upgradient well (MPC-5) and two downgradient wells (HL-99-1 and HL-99-3).
- (d) Historically in these wells, nitrate, arsenic, iron, PCE, and cyanide have been reported at concentrations exceeding MCL criteria (Table 4-3). The MCL for PCE has been exceeded in only downgradient wells; nitrate, arsenic, and iron have exceeded their MCLs in both upgradient and downgradient wells and the MCL for cyanide has been exceeded in only upgradient wells. The December 2010 data is generally consistent with these trends.
- (e) Nitrate was detected in all of the December 2010 samples. The MCL of 10.0 mg/L was exceeded in one sample collected in upgradient well (MPC-5). Monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a decrease in the nitrate concentration in this well and it is currently at a level of 12.8 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentration in area groundwater. This pilot program was shut down when these adverse affects became apparent.
- (f) Metals concentrations in groundwater samples have historically been low (typically below laboratory detection limits). Arsenic was detected in downgradient well HL-

99-3 and upgradient well MPC-5; iron was detected in downgradient wells HL-99-1, HL-99-2, and HL-99-3 and in upgradient well MPC-5; nickel was detected in only upgradient well MPC-5; selenium was detected in upgradient wells MPC-5 and HL-94-1R; and zinc was detected only in downgradient well HL-99-1 during December 2010 monitoring (Table 4-1). The detected metal concentrations were all at or near their detection limits except for iron in downgradient wells HL-99-1 and HL-99-3 (0.39 mg/L and 0.38 mg/L, respectively) and upgradient well MPC-5 (1.68 mg/L) compared to a detection limit of 0.03 mg/L and exceeded the secondary MCL of 0.3 mg/L (based on aesthetic properties such as taste, odor and staining rather than human health standards) in all three wells. Iron has historically fluctuated in HL-99-1 and HL-99-3 from less than 0.03 mg/L to 1.0 mg/L (based on data collected from December 1999 through December 2010). Iron has historically fluctuated at MPC-5 with concentrations ranging from approximately 0.2 mg/L to 4 mg/L (based on data collected from December 1995 through December 2010).

- (g) During the December 2010 sampling event, several volatile organic compounds (VOCs) were detected in samples from downgradient wells, but not in samples from background wells (1,1-dichloroethane, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE). VOCs 1,1,1-trichloroethane and bromodichloromethane were detected only in background wells. Chloroform was the only VOC detected in samples from both downgradient and background wells. PCE was the only VOC to exceed its MCL; all exceedances were in downgradient wells (HL-10-1, HL-90-1, HL-99-2 and HL-99-3).
- (h) Cyanide was detected in a single downgradient well (HL-99-3) and a single upgradient well (MPC-5) during the December 2010 sampling event. Cyanide concentrations in upgradient well MPC-5 (10.4 mg/L) exceeded the MCL (0.2 mg/L). Previous sampling events have shown that cyanide is present at concentrations ranging from approximately 0.77 to 11 mg/L (based on data collected from June 1995 through December 2010) in upgradient well MPC-5. Historically, downgradient detections of cyanide have been well below the MCL indicating that elevated cyanide levels are not attributable to the Helena Landfill (Table 4-3). As noted previously, a

coal gasification plant was historically operated east of the landfill site and could be a source of residual cyanide in groundwater upgradient of the landfill.

4.2 INTER-WELL PREDICTION INTERVAL ANALYSIS

An inter-well prediction interval analysis was used to test for statistically significant differences between background and compliance well concentrations for selected parameters (those above the detection limit in any of the monitoring wells for the December 2010 sampling event). Combining all historical data for the background wells, the Shapiro-Francia Test of Normality was performed for each parameter to determine if the distribution of the background data was normal. All non-detect values were evaluated at one-half the detection limit. If the data was determined not to be normally distributed, the data set was re-evaluated using a natural log (ln) transformation of the data to determine if the data was ln-normally distributed. Inter-well parametric prediction intervals were used when the background data were normally or ln-normally distributed. In cases where the background data were not normally or ln-normally distributed, a non-parametric prediction limit was used. Results of the prediction interval test are summarized in Table 4-4. Documentation for each of these statistical tests used is included in Appendix B of this report.

As shown on Table 4-4, pH, chloride, arsenic, 1,1-dichloroethane, cis-1,2-dichloroethane, dichlorodifluoromethane, PCE, and TCE have statistically greater concentrations in downgradient wells than upgradient wells.

4.3 TREND ANALYSIS

In addition to evaluating the chemical concentrations in upgradient and downgradient wells around the landfill for the December 2010 sampling event, it is also important to evaluate concentration trends of key constituents over time. Using the Mann-Kendall test, statistical testing for trends was performed for each downgradient exceedance of its respective inter-well prediction interval as discussed in Section 4.2. All non-detect values were evaluated as zero to prevent the detection of false trends when parameters are detected at concentrations less than the reporting limit or when the reporting limits have changed over time. This test

TABLE 4-4. RESULTS OF INTER-WELL PREDICTION INTERVAL TESTS

Parameter	Background Wells		Downgradient Wells				
	Distribution ⁽¹⁾	Prediction Limit ⁽²⁾	HL-10-1	HL-90-1	HL-99-1	HL-99-2	HL-99-3
pH (s.u.)	Non-Norm	6.89-7.91	7.8	7.9	7.9	7.9	8.0
Specific Conductance (µmhos/cm)	Non-Norm	4116	1230	1400	1250	954	947
Sulfate	Non-Norm	1870	130	130	150	130	150
Chloride	Non-Norm	164.6	110	170	95	49	53
Nitrate+Nitrite as N	ln-Norm	101.0	9.05	9.08	8.90	7.57	8.82
Arsenic (Dissolved)	Non-Norm	0.0088	<0.005	<0.005	<0.005	<0.005	0.009
Iron (Dissolved)	Non-Norm	2.96	<0.03	<0.03	0.39	0.14	0.38
Nickel (Dissolved)	Non-Norm	0.032	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (Dissolved)	Non-Norm	0.01	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (Dissolved)	Non-Norm	0.021	<0.01	<0.01	0.01	<0.01	<0.01
1,1,1-Trichloroethane	Non-Norm	0.0054	<0.001	<0.001	<0.001	<0.001	<0.001
1,1-Dichloroethane	ND	0.001	0.0018	0.0018	<0.001	0.0027	0.0018
Bromodichloromethane	Non-Norm	0.0042	<0.001	<0.001	<0.001	<0.001	<0.001
Chloroform	Non-Norm	0.036	<0.001	<0.001	0.0027	0.0020	0.0024
Cis-1,2-Dichloroethene	ND	0.001	0.0015	0.0014	0.0017	<0.001	<0.001
Dichlorodifluoromethane	ND	0.001	0.0014	<0.001	<0.001	0.0023	<0.001
Tetrachloroethene (PCE)	ND	0.001	0.0065	0.0060	0.0032	0.0059	0.0051
Trichloroethene (TCE)	ND	0.001	0.0014	0.0013	<0.001	0.0012	<0.001
Cyanide (Total)	Non-Norm	10.6	<0.005	<0.005	<0.005	<0.005	0.029
Chemical Oxygen Demand (COD)	Non-Norm	66.7	<1	2	3	1	4

(1) Normality was calculated using the Shapiro-Francia test.

Norm (X%) = data normally distributed at X% level of significance.

ln-Norm (X%) = data ln-normally distributed at X% level of significance.

Non-Norm = data not normally or ln-normally distributed at 95% or 99% level of significance.

ND = all background data below detection limits. Value shown is the detection limit.

(2) Prediction limits calculated as follows:

Normal or ln-normal distribution: parametric prediction interval (99% one-sided, two-sided for pH)

Non-normal distribution: non-parametric prediction interval (99% one-sided, two-sided for pH)

ND: any detectable concentrations in compliance wells are considered significant.

Bold values indicate statistically significant results.

NA - not analyzed

was not performed for well HL-10-1 as there is only very limited data for this well. The results of these analyses are summarized in Table 4-5. Documentation for these statistical tests is included in Appendix B of this report.

TABLE 4-5. RESULTS OF MANN-KENDALL TREND ANALYSES

Parameter	HL-90-1	HL-99-1	HL-99-2	HL-99-3
pH				No Trend
Chloride	No Trend			
Arsenic				No Trend
1,1-Dichloroethane	Decreasing		Increasing	No Trend
Cis-1,2-Dichloroethane	Increasing	No Trend		
Dichlorodifluoromethane			No Trend	
Tetrachloroethene (PCE)	Decreasing	Decreasing	No Trend	Decreasing
Trichloroethene (TCE)	Decreasing		Increasing	

Note: Grayed boxes did not have downgradient exceedances of the respective inter-well prediction interval and therefore a trend analysis was not performed.

There were no statistical trends for pH, chloride, and arsenic. 1,1-Dichloroethane is showing a decreasing trend in HL-90-1 and an increasing trend in HL-99-2; this compound is a breakdown product of 1,1,1-trichloroethane, historically found primarily in wells upgradient of the Helena landfill. Cis-1,2-dichloroethane is showing an increasing trend in HL-90-1; according to National Primary Drinking Water Regulations, cis-1,2-dichloroethane is formed as a breakdown product from the reductive dehalogenation of the common industrial solvents TCE and PCE. PCE is showing decreasing trends in downgradient wells HL-90-1, HL-99-1, and HL-99-3. TCE is showing decreasing and increasing trends in downgradient wells HL-90-1 and HL-99-2, respectively.

4.4 TEMPORAL CONCENTRATION PLOTS

This report focuses on concentration trends for PCE and nitrate because they are the only constituents consistently exceeding their MCLs in downgradient monitoring wells. PCE was also the focus of the Corrective Measures Assessment for the landfill (Hydrometrics, 1995).

In an attempt to reduce concentrations of PCE in compliance well HL-90-1, the City installed a groundwater extraction system in the spring of 2000 (Hydrometrics, 1999b). This treatment

system involves pumping wells HL-99-1, HL-99-2 and HL-99-3 to intercept PCE leaving the landfill, and treating the water to remove VOCs prior to land application on Bill Roberts Golf Course. These wells have been included in groundwater monitoring events along with compliance wells HL-10-1 and HL-90-1 to evaluate the progress of this new groundwater extraction system.

Trends in PCE concentrations over time for the past ten years for the downgradient monitoring wells are shown on Figure 4-1. PCE concentrations exceeded the MCL value of 0.005 mg/L in monitoring wells HL-10-1, HL-90-1, HL-99-2, and HL-99-3 for December 2010. Historically, the PCE concentrations in pumping wells HL-99-2 and HL-99-3 have shown seasonal fluctuations and decreasing trends in HL-99-3 since their installation in 1999. Compliance well HL-90-1 has shown definite improvement since the installation of the groundwater extraction system in June 2000, averaging 0.0146 mg/L before the extraction system and 0.0073 mg/L after. Compliance well HL-10-1 was installed in May of 2010 has concentrations of PCE just above the MCL, but not enough data is available to determine a trend.

Nitrate concentrations in monitoring wells that have exceeded the MCL of 10 mg/L in the past ten years are shown on Figure 4-2. The concentrations of nitrate in downgradient wells HL-99-1 and HL-99-3 have shown minor fluctuations in nitrate concentrations over the last several years and have only exceeded the MCL once in June 2009. The MCL was not exceeded in any downgradient wells during the December 2010 sampling event.

Historically, upgradient wells have shown the highest levels of nitrate in groundwater (Figure 4-2). Upgradient monitoring well MPC-5 showed an increasing trend from 1998 through 2005 reaching a maximum of 73.0 mg/L. Since then, there has been a generally decreasing trend in the nitrate concentration in this well and is currently at a level of 12.8 mg/L, exceeding the MCL of 10 mg/L. Discussions with MPC representatives revealed that an attempt to remediate cyanide (from a historic coal gasification plant that was operated just east of the landfill) through oxidation may have inadvertently increased nitrate concentrations

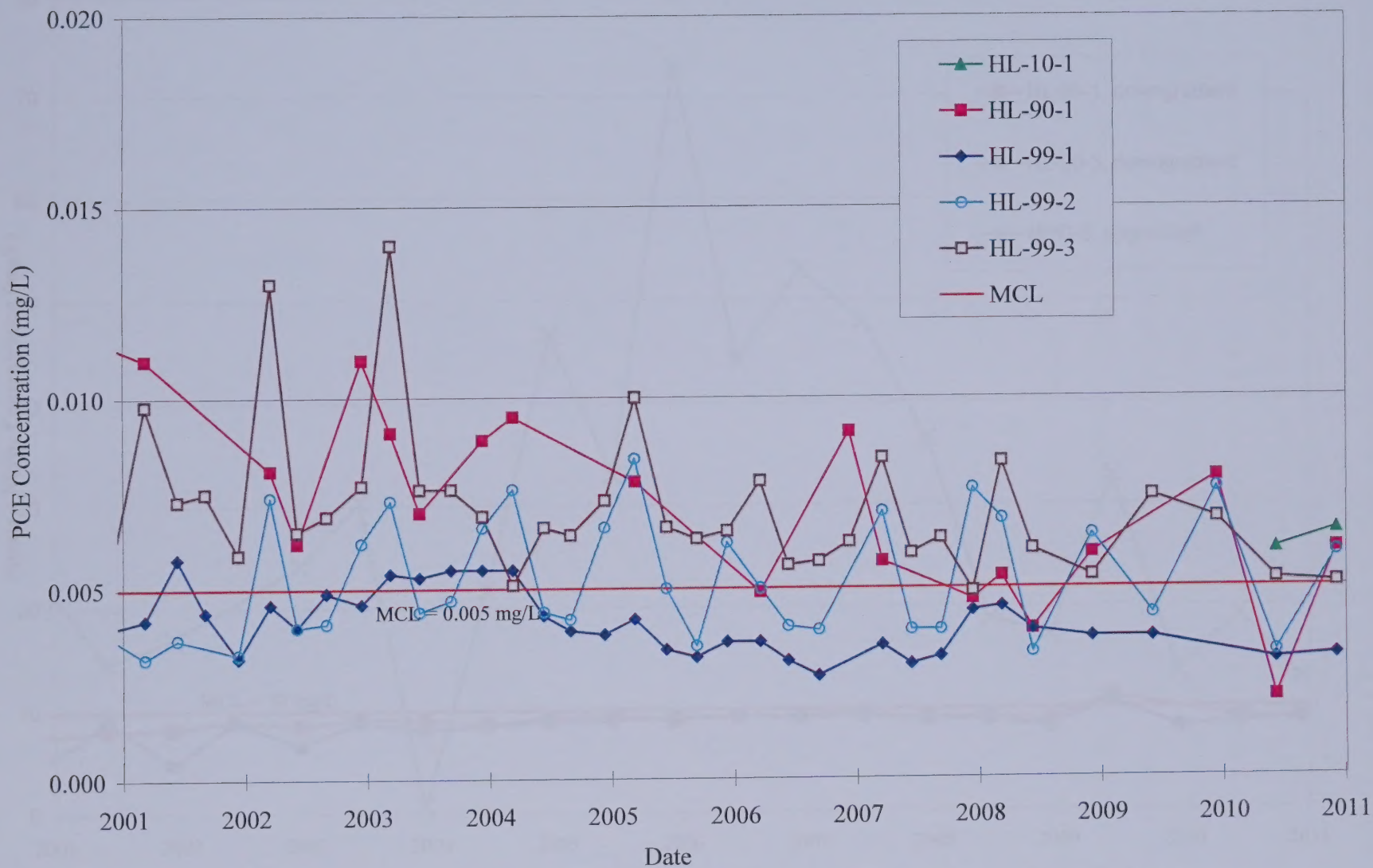


Figure 4-1. Temporal Trends in Tetrachloroethene Concentrations at Selected Monitoring Wells

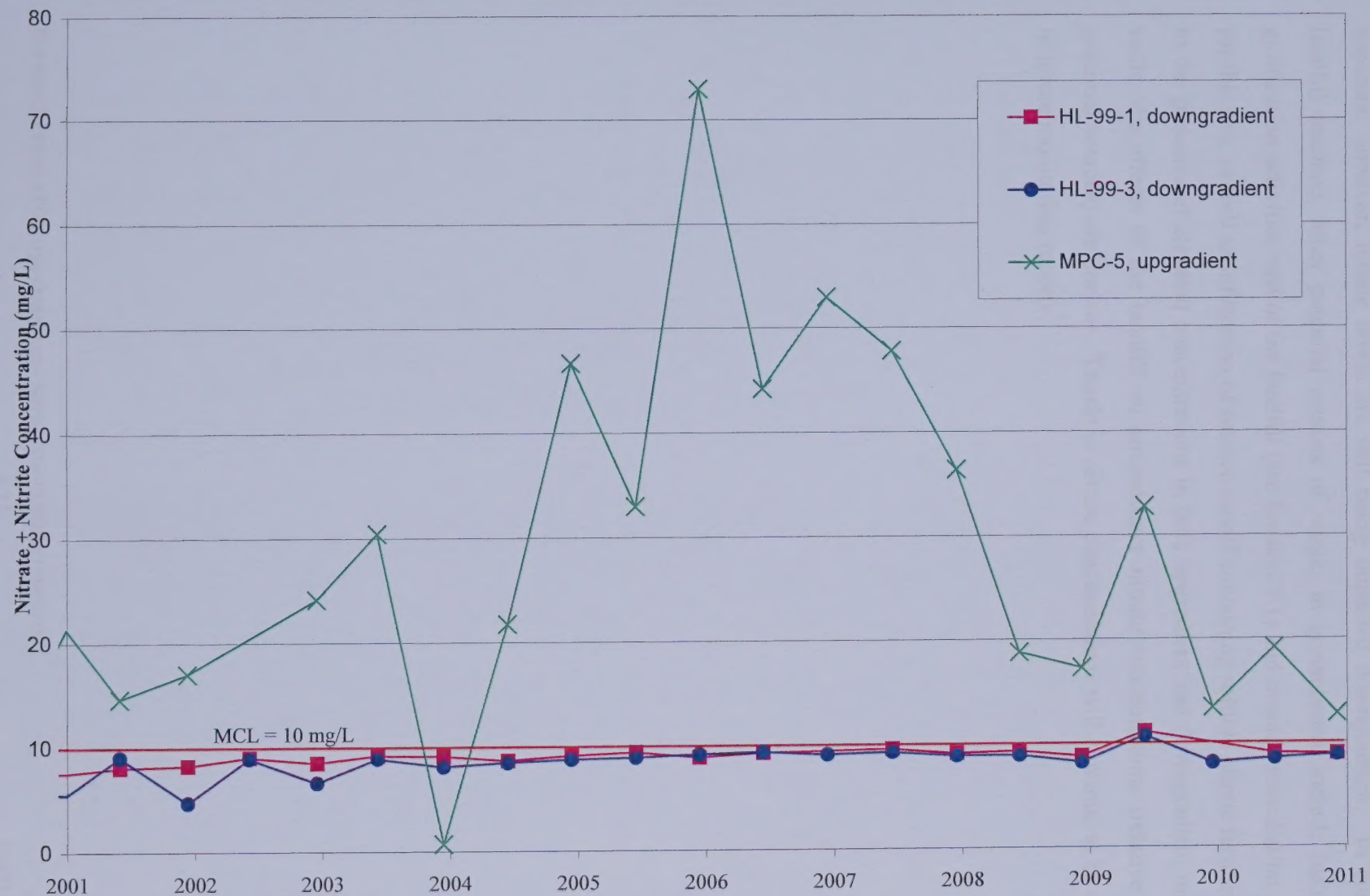


Figure 4-2. Temporal Trends in Nitrate Concentrations at Selected Monitoring Wells

in area groundwater. This pilot program was shut down when these adverse affects became apparent; however, nitrate levels are still being impacted downgradient. In addition to landfill leachate, other potential sources of nitrate in groundwater include historic coal gasification activities east of the landfill (see Section 3.1) and cyanide remediation activities for this site, as well as infiltration of surface runoff containing soluble nitrate fertilizers. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources) are unclear. Trends in nitrate concentrations will continue to be evaluated in future monitoring reports.

5. DOMESTIC WELL DATA EVALUATION

Two domestic wells were also sampled during the December 2010 sampling event. For wells 5 and 16, the only VOCs reported at concentrations above the detection limit were chloroform and tetrachloroethene; all detections were below their respective MCLs. The concentrations for all parameters for both wells were similar to concentrations measured in these wells during the June 2010 sampling event. Trends in PCE concentrations over the last ten years for the sampled domestic wells are shown on Figure 5-1. Both of these wells are used only for irrigation and the homes of these domestic wells have been connected to the City water supply.

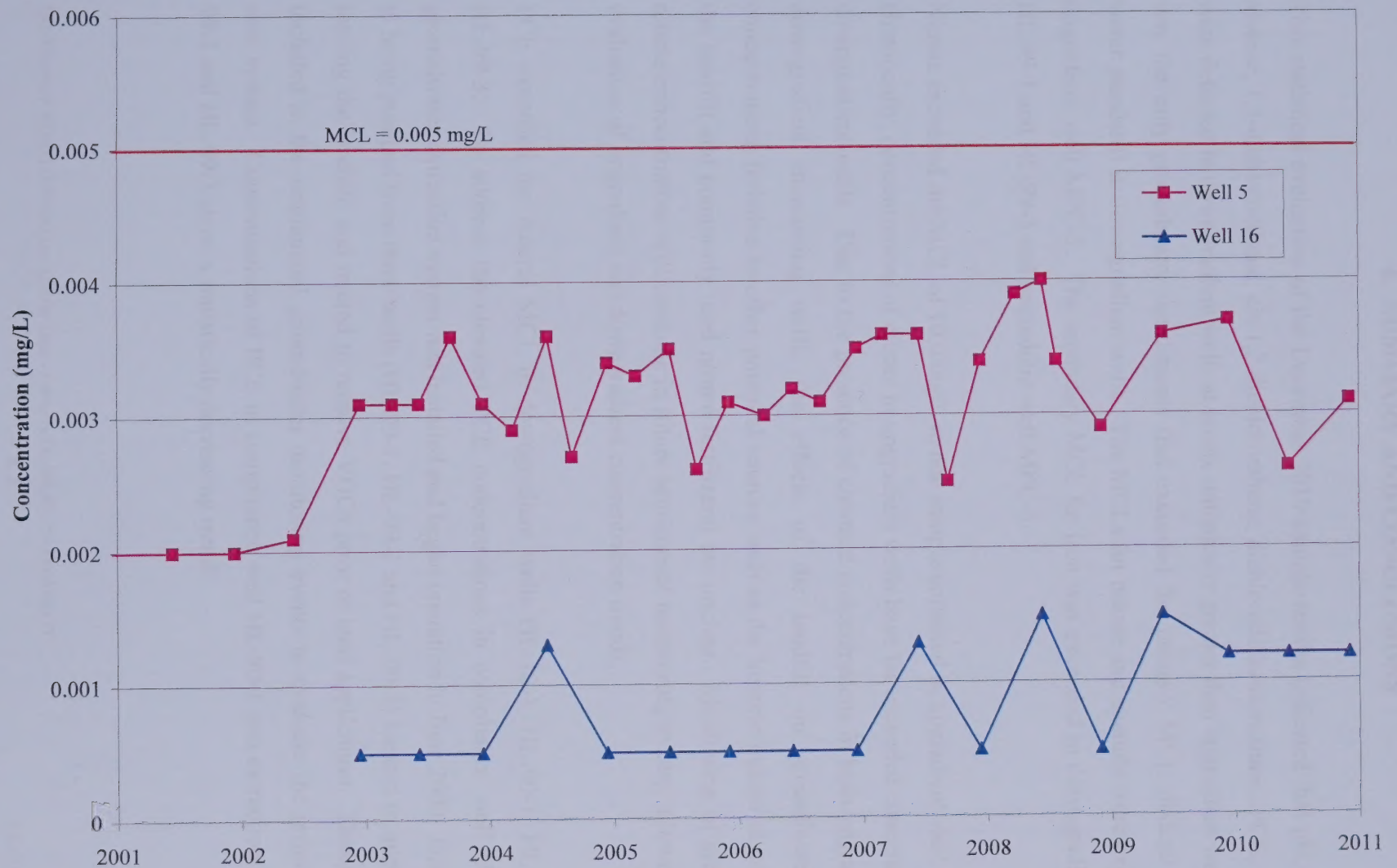


Figure 5-1. Temporal Trends in PCE Concentrations in Domestic and Irrigation Wells

6. SUMMARY AND CONCLUSIONS

This statistical evaluation of the December 2010 sample results indicated that pH, chloride, arsenic, 1,1-dichloroethene, cis-1,2-dichloroethene, dichlorodifluoromethane, PCE, and TCE were detected in downgradient wells at levels statistically greater than upgradient wells. PCE was the only groundwater constituents that exceeded the primary MCL (federal drinking water standard) in downgradient wells. The MCLs for nitrate and cyanide were exceeded in upgradient well MPC-5. The secondary MCL for iron was exceeded in downgradient wells HL-99-1 and HL-99-3 and upgradient well MPC-5.

Nitrate exceeded the MCL of 10.0 mg/L in one sample collected in upgradient well (MPC-5). Historically, concentrations of nitrate in upgradient wells have far exceeded concentrations in downgradient wells. Due to the presence of elevated concentrations in both upgradient and downgradient monitoring wells, the effects of the landfill on groundwater nitrate concentrations (relative to other potential sources such as the historic industrial area east of the landfill and commonly used nitrate fertilizers) are unclear. Monitoring of groundwater nitrate concentrations will continue in future semiannual monitoring events, allowing further evaluation of upgradient and downgradient concentration trends.

PCE exceeded the federal MCL in downgradient wells HL-10-1, HL-90-1, HL-99-2 and HL-99-3. To address the elevated PCE concentrations in compliance well HL-90-1, a groundwater extraction system was installed and began operation in June 2000. Groundwater is being pumped from three wells (HL-99-1, HL-99-2 and HL-99-3) located to intercept PCE leaving the landfill, and treated to remove VOCs prior to land application. These wells are included in the semiannual groundwater monitoring events to evaluate the progress of the new system. Concentrations of PCE in compliance well HL-90-1 and extraction wells HL-99-1 and HL-99-3 show a statistically decreasing trend.

7. REFERENCES

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**DATA VALIDATION REPORT
GROUNDWATER QUALITY DATA
SEMI-ANNUAL SAMPLING
DECEMBER 2010**

CITY OF HELENA LANDFILL

**Report for
CITY OF HELENA
HELENA, MONTANA**

APPENDIX A

**DATA VALIDATION REPORT
(APPENDICES IN DIGITAL FORMAT)**

 **Hydrometrics, Inc.**
measuring time, data and resources

FEBRUARY 2011

**DATA VALIDATION REPORT
GROUNDWATER QUALITY DATA
SEMI-ANNUAL SAMPLING
DECEMBER 2010**

CITY OF HELENA LANDFILL

Prepared For:
CITY OF HELENA
HELENA, MONTANA



Hydrometrics, Inc.
consulting scientists and engineers

FEBRUARY 2011

**DATA VALIDATION REPORT
CITY OF HELENA LANDFILL**

**Groundwater Samples Collected in
December 2010
(Semi-Annual Sampling)**

Prepared by
Hydrometrics, Inc.
3020 Bozeman Avenue
Helena, MT 59601

February 2011

TABLE OF CONTENTS

LIST OF APPENDICES	II
GLOSSARY OF TERMS.....	III
SUMMARY.....	1
1. INTRODUCTION.....	3
2. DELIVERABLES.....	4
3. FIELD QUALITY CONTROL SAMPLES	4
4. LABORATORY PROCEDURES.....	5
5. DETECTION LIMITS	6
6. LABORATORY BLANKS.....	6
7. LABORATORY BLANK SPIKES.....	6
8. SURROGATE SPIKES	6
9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD).....	7
10. INTERPARAMETER RELATIONSHIPS.....	7
11. HISTORICAL COMPARISON.....	7
12. DATA QUALITY OBJECTIVES	7
REFERENCES	9

LIST OF APPENDICES (SUBMITTED IN DIGITAL FORMAT)

APPENDIX 1: TABLES

TABLE 1 – Data Validation Codes and Definitions

TABLE 2 – Historical Comparison

APPENDIX 2: DATABASE

APPENDIX 3: HYDROMETRICS FIELD NOTES

APPENDIX 4: ENERGY LABORATORIES ANALYTICAL REPORT

GLOSSARY OF TERMS

CCB.....	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CLP	Contract Laboratory Program
CRDL.....	Contract Required Detection Limit
FAA	Flame Atomic Absorption
GFAA.....	Graphite Furnace Atomic Absorption
HGAA	Hydride Generation Atomic Absorption
ICB	Initial Calibration Blank
ICP	Inductively Coupled Plasma
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
LCS	Laboratory Control Sample
MSA.....	Method of Standard Additions
PB.....	Preparation Blank
PRDL	Project Required Detection Limit
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD.....	Relative Percent Difference
RSD.....	Relative Standard Deviation
SOW.....	Statement of Work
TDS.....	Total Dissolved Solids

SUMMARY

Laboratory analysis for groundwater samples collected for the December 2010 sampling event as part of the City of Helena Landfill have been reviewed and validated. This review has been in accordance with the "Revised Sampling and Analysis Plan; City of Helena Landfill; Groundwater, Surface Water, and Landfill Gas Monitoring Activities" (Hydrometrics, March 2008). All samples were analyzed at Energy Laboratories in Helena, Montana.

Data results are qualified when associated field quality control samples have not met validation criteria. Not all quality control deficiencies are equally serious and some may not have any practical impact on the usefulness of the data. A summary of quality control violations found in this validation follows:

Violations involving laboratory quality control samples:

- In the QA/QC Summary Report provided by Energy Laboratories, matrix spike and matrix spike duplicate review showed several exceedances. However, at this level of validation, laboratory exceedances are noted but no flagging of the data occurs.
- It should also be noted that Energy Laboratories raised the reporting limit of sulfate, nitrate + nitrite as N, chloride, and cyanide due to sample matrix interference. The reporting limits used for dissolved antimony and thallium were lower than the requested limits, and did not seem to impact the results.
- Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.
- It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several metals analysis. However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.

Deviations from the prescribed quality control procedures and/or exceedances of quality control limits have been noted, and results have been flagged in the database. The data quality

DATA VALIDATION REPORT

1. INTRODUCTION

This validation applies to organic analytes for 26 water samples collected for the City of Helena Landfill semi-annual monitoring project during the December 2010 sampling event. The total number of samples included: twelve field observations, one field duplicate, two field blanks (DI and Rinsate) and one trip blank.

All samples were submitted for volatile organic analyses, and select samples were submitted for inorganic analyses (metals and wet chemistry) as follows:

SITE CODE	SAMPLE NUMBER	WATER LEVEL	FIELD PARAMETERS ¹	METALS AND COMMONS ²	VOLATILES METHOD 8260 ³
INF GALLERY	HL-1012-122	X			
MPC-2	HL-1012-124	X			
Res #16	HL-1012-113		X		X
Res #5	HL-1012-112		X		X
HL-90-2	HL-1012-118	X			
HL-06-1	HL-1012-101	X	X	X	X
HL-90-3	HL-1012-119	X			
HL-10-01	HL-1012-107	X	X	X	X
HL-94-1R	HL-1012-104	X	X	X	X
HL-94-2R	HL-1012-100	X			
HL-94-3	HL-1012-120	X			
HL-90-1	HL-1012-105	X			
MPC-1	HL-1012-123	X			
DI BLANK	HL-1012-111		X	X	X
EPA-1	HL-1012-116	X			
MPC-5	HL-1012-109	X	X	X	X
HL-99-1	HL-1012-102	X	X	X	X
HL-10-01	HL-1012-106	X	X	X	X
HL-99-2	HL-1012-103	X	X	X	X
HL-99-3	HL-1012-108	X	X	X	X
RINSATE BLANK	HL-1012-110		X	X	X
TRIP BLANK	HL-1012-114				X
I-1	HL-1012-121	X			
82-3	HL-1012-115	X			
EPA-2	HL-1012-117	X			
EPA-4	HL-1012-125	X			

- 1.) Field parameters include pH, SC, and water temperature.
- 2.) Metals and commons include those compounds listed in the first half of ARM 17.50.708 Table 1.
- 3.) Volatile organic compounds include those listed in the second half of ARM 17.50.708 Table 1.

- Validation procedures used are generally consistent with:

(Check all that apply)

- ☒ EPA CLP National Functional Guidelines for Inorganics Data Review
- ☒ EPA CLP National Functional Guidelines for Organic Data Review
- ☒ Work Plan (Sampling and Analysis Plan, City of Helena Landfill Groundwater Monitoring Activities, Hydrometrics, March 2008)

- Overall level of validation:

- ☐ Contract Laboratory Program (CLP)
- ☒ Standard (see following notes)
- ☐ Visual

NOTES: The review of this data includes checking all field and laboratory quality control samples; flagging for exceedances in field quality control; and calculating precision, accuracy, and completeness for both laboratory and field quality control samples.

2. DELIVERABLES

- All laboratory document deliverables were present as specified in the CLP-Statement of Work (CLP-SOW), EPA, 1993 and/or the project contract.

☒ Yes
☐ No

- All documentation of field procedures was provided as required.

☒ Yes
☐ No

- Consistency with project requirements

Sampling was completed in order as stated in the SAP.

☒ Yes (see following notes)
☐ No

NOTES: It should be noted that the wells were not sampled in the order listed in the SAP. The order of sampling was followed for all wells that do not use dedicated or disposable equipment. Any variances in sampling order were noted in the field book.

3. FIELD QUALITY CONTROL SAMPLES

- Field blanks

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

DI, trip, rinsate, or any other field blanks have been carried out at the proper frequency.

☒ Yes
☐ No

Reported results on the field blanks are less than the contract required detection limits (CRDL) or the project required detection limits (PRDL) if project detection limits have been specified.

☒ Yes
☐ No

- **Field duplicates**

Field duplicates have been collected at the proper frequency.

☒ Yes

☐ No

Field duplicate relative percent differences (RPD's) were within the required control limits (RPD of 20 percent or less for water matrix, 35 percent or less for soil matrix). If the sample or duplicate result is less than 5 times the PRDL, the RPD criteria are not used. In these cases, the difference between the sample and the duplicate results must be within $\pm$ the PRDL for water matrix, within $\pm$ 2 times the PRDL for soil matrix.

☒ Yes

☐ No

- **Field standards**

Field standards were sent at the proper frequency

☐ Yes

☐ No

☒ NA - Not required by the work plan.

4. LABORATORY PROCEDURES

- **Laboratory procedures followed**

☐ CLP-SOW

☒ SW-846

☒ Methods for Chemical Analysis of Water and Wastes

☐ XRF Standard Operating Procedures

☐ Other

- **Samples were received by the laboratory at the proper temperature**

☒ Yes

☐ No

- **Holding times met**

☐ Yes

☒ No (see the following notes)

NOTES: Energy Laboratories exceeded the holding time for pH for all samples submitted. However, as a rule holding times for laboratory pH measurements are frequently exceeded because measurements are typically not conducted "immediately", but rather as soon as practicable. Therefore, no qualifiers are applied for lab pH holding time exceedances.

- **Consistency with project requirements**

Analyses were carried out as requested.

☒ Yes

☐ No

Project specified methods were used.

☒ Yes (see following notes)

☐ No

NOTES: It should be noted that Energy Laboratories used a different method than stated in the work plan on the following parameters: pH, SC, cyanide, and several metals

analysis. However, no associated data was flagged because the methods used are considered comparable to stated methods in work plan.

5. DETECTION LIMITS

- Reporting detection limits met project required detection limits (PRDL).
☒ Yes (see following notes)
☐ No

NOTES: It should be noted that Energy Laboratories raised the reporting limit for sulfate, nitrate + nitrite as N, chloride, and cyanide due to a sample matrix interference. The reporting limits used for several metals analysis were lower than the requested limits, and did not seem to impact the results.

6. LABORATORY BLANKS

Please note that the highest blank value associated with any particular analyte is the blank value used for the flagging process.

- Preparation/Method blanks**

Preparation/Method blanks were prepared and analyzed at the required frequency.

☒ Yes
☐ No

All analytes in the preparation blank were less than the CRDL (or PRDL if a project detection limit has been specified).

☒ Yes
☐ No

7. LABORATORY BLANK SPIKES

- Blank Spikes**

Blank spikes (organics) were prepared and analyzed at the required frequency.

☒ Yes
☐ No

Blank spike recoveries were within control limits.

☒ Yes
☐ No

8. SURROGATE SPIKES

- Surrogate Spikes**

Surrogate spikes were prepared and analyzed at the required frequency.

☒ Yes
☐ No

Surrogate spike recoveries were within control limits.

☒ Yes
☐ No

9. MATRIX SPIKE /MATRIX SPIKE DUPLICATES (MS/MSD)

- Matrix spike samples were analyzed at the proper frequency.

☒ Yes
☐ No

Matrix spike recoveries were within control limits.

☐ Yes
☒ No (see following notes)

- Matrix spike duplicate samples were analyzed at the proper frequency.

☒ Yes
☐ No

Matrix spike duplicate RPD's were within control limits.

☐ Yes
☒ No (see following notes)

NOTES: Both matrix spike and matrix spike duplicate samples had several QC exceedances. At this level of validation, these exceedances are only noted and no flagging of the associated data occurs.

10. INTERPARAMETER RELATIONSHIPS

- The following relationships have been checked for all data from the December 2010 monitoring:

☒ Lab SC versus field SC

☒ Lab pH versus field pH

Lab SC versus field SC: A comparison of the field and lab SCs using a percent difference (%D) criteria for evaluation purposes, showed that none of the SC pairs exceeded the ten percent comparison criteria.

Lab pH versus field pH: A comparison of the field and lab pHs using a percent difference (%D) criteria for evaluation purposes, showed that also three of the pH pairs exceeded the ten percent comparison criteria.

11. HISTORICAL COMPARISON

Current sampling event data (December 2010) were compared to historical data (December 2007 through November 2010). The data for the December 2010 sampling event was similar to historic data.

12. DATA QUALITY OBJECTIVES

- Project data quality objectives (DQO's) met.

☒ Yes
☐ No

Accuracy

Accuracy for this project is the agreement between a measured value and a true value and is measured by the recoveries on the laboratory matrix spikes and laboratory control samples.

Accuracy for this sampling event was 99 percent.

Precision

Precision for this project is the degree of variability between duplicate measurements. Laboratory analytical variability is measured by laboratory duplicates; field duplicates are a measure of overall variability in both field sampling and laboratory techniques.

Laboratory precision was 99 percent for this sampling event.

Field precision was 100 percent for this sampling event.

Completeness

The target completeness for this project is 90 percent of the measurements valid (not rejected). This percentage is based on the number of valid measurements compared to the number of planned measurements. Completeness for this sampling event was 100 percent.

DATA VALIDATION REPORT

Prepared by: Ericka Vallance

Reviewed by: Jodi Bingham, P.E.

REFERENCES

- Hem, J.D., 1992. Study and Interpretation of the Chemical Characteristics of Natural Water, 3rd Edition. US Geological Survey Water Supply Paper 2254.
- Hydrometrics Project Work Plan. Sampling and Analysis Plan City of Helena Landfill Groundwater Monitoring Activities, March 2008.
- U.S. Environmental Protection Agency, 1990. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, 3rd Edition.
- U.S. Environmental Protection Agency, 1993. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. October 2004.
- U.S. Environmental Protection Agency, 1994. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. October 2004.

Data Validation and Statistical
Evaluation of December 2010
Groundwater Quality Data
City of Helena Landfill
Appendix A - Data Validation (Appendices Only)



3020 Bozeman
Helena, MT 59601
(406) 443-4150

Hydrometrix, Inc.
Consulting Scientists and Engineers

February 2011

APPENDIX B

STATISTICAL ANALYSIS REPORTS (IN DIGITAL FORMAT)

Hydrometrics, Inc.
Consulting Scientists and Engineers
3020 Bozeman
Helena, MT 59601
(406) 443-4150



February 2011

Appendix B - Statistical Analysis Reports
City of Helena Landfill
Groundwater Quality Data
Evaluation of December 2010
and Validation and Status

